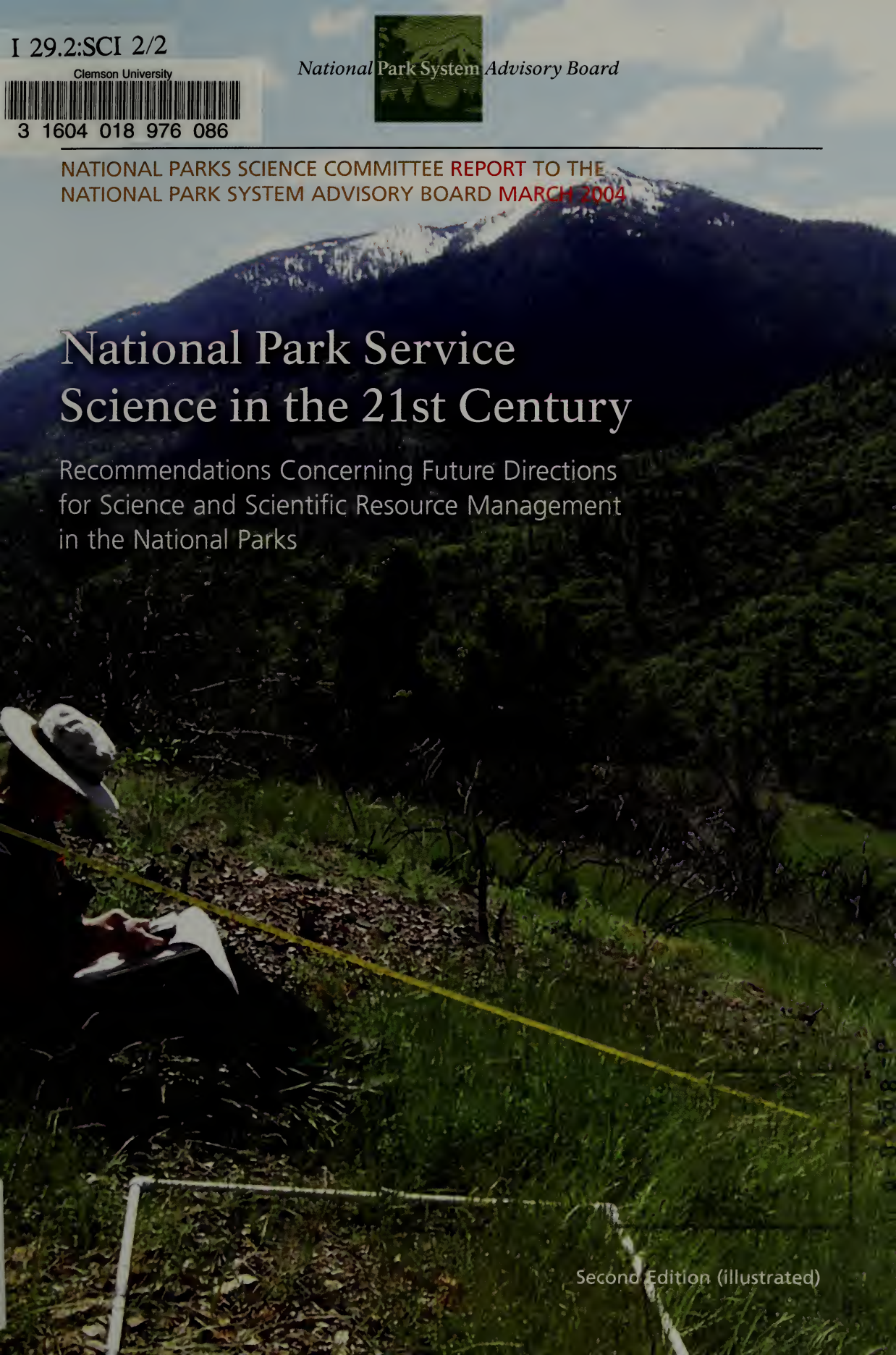
I 29.2:SCI 2/2
Clemson University
3 1604 018 976 086

National Park System Advisory Board

NATIONAL PARKS SCIENCE COMMITTEE REPORT TO THE
NATIONAL PARK SYSTEM ADVISORY BOARD MARCH 2004

National Park Service Science in the 21st Century

Recommendations Concerning Future Directions for Science and Scientific Resource Management in the National Parks



Second Edition (illustrated)

The report which follows—*National Park Service Science in the 21st Century*—a National Parks Science Committee Report to the National Park System Advisory Board, 2004, was adopted unanimously by the Board on August 12, 2003. The report has been revised and edited in accordance with the direction of the Board.

Members Participating
Douglas P. Wheeler, Chairman
Robert S. Chandler, Vice Chairman
Margaret L. Brown
Sylvia A. Earle
Jerry N. Hruby
Shirley Mahaley Malcom
Janet Snyder Matthews
Gary Paul Nabhan
Jay Parmer
Daniel L. Ritchie
Thomas B. Williams

Member Absent
Michael Kammen

In 2006–2009, the NPS Natural Resource Program Center, Office of Education and Outreach, furnished photographs, captions, and a new layout for this illustrated second edition. John Francis, National Park System Advisory Board member since March 2004, endorsed this edition in December 2006; principal author and science committee member Sylvia A. Earle approved it in June 2008. This report can be downloaded at http://www.nature.nps.gov/ScienceResearch/ScienceCommitteeReport2ndEdition.pdf.

First Edition—March 2004
Second Edition (illustrated)—January 2009 (D-1589A)

ON THE COVER

Whiskeytown National Recreation Area, California. A biological technician samples vegetation to assess the response of both native and nonnative vascular plants to a wildfire in 2004

National Park Service Science in the 21st Century

A National Parks Science Committee Report to the National Park System Advisory Board

2004

PUBLIC DOCUMENTS
DEPOSITORY ITEM

APR 16 2009

CLEMSON
LIBRARY

2009-0258-P

CONTROLLING NONNATIVE SPECIES

Great Smoky Mountains National Park, Tennessee and North Carolina. A natural resource manager sprays insecticidal soap as part of a coordinated program of treatments to combat hemlock woolly adelgid (*Adelges tsugae*), a nonnative insect forest pest.

National Park Service Science in the 21st Century

A National Parks Science Committee Report to the National Park System Advisory Board

2004

Sylvia A. Earle
National Geographic Society

Robert Chandler
National Park Service (retired)

Larry Madin
Woods Hole Oceanographic Institute

Shirley M. Malcom
American Association for the Advancement of Science

Gary Paul Nabhan
Center for Sustainable Environments, Northern Arizona University

Peter Raven
Missouri Botanical Gardens

Edward O. Wilson
Harvard University

Second Edition (illustrated)

For if one link in nature's chain might be lost, another might be lost, until the whole of things might vanish by piecemeal.

—THOMAS JEFFERSON

INDICATOR SPECIES

Congaree National Park, South Carolina. A biological science technician examines a specimen of the slime mold *Arcyria cinerea*. The diversity of slime molds in a given habitat may correspond to environmental stresses, thereby serving as a good indicator of ecological health.

CONTENTS

Foreword vii

Introduction 1

Natural Systems in the 21st Century 5

Evaluating the Natural Resource Challenge 9

Future Directions for National Park Service Science 15

Summary 25

Appendix: Natural Resource Challenge Components 27

America's National Park System represents a profoundly egalitarian concept—landscapes of incomparable beauty and grandeur that are to be shared and enjoyed by all people.

Delicate Arch seen through Frame Arch, Arches National Park, Utah.

FOREWORD

IN MAY 2002, the Director of the National Park Service asked the National Park System Advisory Board to review the Service's Natural Resource Challenge program and offer recommendations concerning future directions for science and scientific resource management in the national parks. The Advisory Board tasked its National Parks Science Committee with developing those recommendations.

The Science Committee considered the history of natural resource management in the National Park System and a wide range of issues relating to program operations; policies guiding the natural resource management function; and opportunities facing the National Park Service, an agency long revered by the American public, which is charged with pursuing the highest conservation and preservation purposes.

America's National Park System represents a profoundly egalitarian concept—landscapes of incomparable beauty and grandeur that are to be shared and enjoyed by all people. From the very beginning, the national park idea marked a dramatic, historic step in nature preservation, with its mandate that the parks be retained "in their natural condition," thereby extending the sharing beyond the human species to all native flora and fauna within the national parks.

The Science Committee believes that this broad, inclusive sharing of unique segments of the American landscape, with all of their native species, forms the vital core of the national park idea, endowing it with high idealism and purpose that have spread throughout the nation and around the world. The Committee views this high purpose as self-evident, and calls on the National Park Service to continue strengthening its dedication to these ideals as the most fundamental precepts of national park management.

This report is respectfully submitted to the National Park System Advisory Board by Sylvia A. Earle, with the acknowledgment of, and gratitude to, members of the National Parks Science Committee; and also with thanks to the National Park Service for its invaluable assistance.

The National Park Service has no choice: Mastering the science required to maintain ecological integrity is central to its unimpairment mandate.

ECOLOGICAL INTEGRITY

Sequoia National Park, California. National parks have long been appreciated for their spectacular wonders and alluring qualities. Slower in coming has been broad recognition of the need for a sophisticated science program of the National Park Service to help managers preserve the ecological integrity of the parks.

INTRODUCTION

MORE THAN A CENTURY AGO, farsighted congressional leaders began setting aside landscapes on a truly grand scale by creating a system of national parks in the United States. They recognized that these majestic areas represent America's natural heritage, in all of its grandeur, nobility, and complexity, and that they must be protected for the benefit of the public. And they specifically mandated that the national parks be left "unimpaired for the enjoyment of future generations."

National parks are spiritual places—sacred, and inspirational. They are places with great restorative powers, of enormous benefit in a stressful modern world. From the beginning, and continuing into the present, national parks have been theaters of education—classrooms for science and the humanities. In the parks, millions of Americans have expanded their knowledge of natural history through experiences that have served to foster better citizenship. Appreciation of the scenic beauty of the national parks has nurtured a greater understanding of the ecological complexity and biodiversity of the world.

Over the years, science has not fared well in the National Park Service. In an effort to reverse that trend, Service leadership recently created a program to double the science effort in the national parks—known as the Natural Resource Challenge. To date, the Challenge has greatly strengthened the Park Service's scientific natural resource management capability, as well as its ability to take better advantage of public and private partnerships to further enhance ecological management. The Natural Resource Challenge represents more than just an increase in funding—it has actually created a historic shift in emphasis, moving national park management toward the heart of the National Park Service mission. The Service has long excelled in managing recreational tourism, but by virtue of its mandate, it has been cast in the leadership role in nature preservation. The mission to preserve the parks unimpaired includes the ecological integrity of park resources. However, national parks with decreased biological diversity and diminished natural systems can in no way be considered unimpaired. Thus, the National Park Service has no choice: Mastering the science required to maintain ecological integrity is central to its unimpairment mandate. And to accomplish this mastery, the Service must be given wide latitude in establishing and managing its own fully constituted science program.

Scientific knowledge serves as the foundation for preserving national parks, so science must be a fully integrated part of the National Park Service organi-

Every conceivable effort must be made to marshal the necessary resources to preserve the integrity of the parks and the life residing within them.

BIODIVERSITY PRESERVATION

Bison, Badlands National Park, South Dakota. Long successful in managing parks for public enjoyment, the National Park Service has an opportunity in the 21st century to realize its full potential for leadership in the preservation of biodiversity.

zational culture, as reflected in the Service's value system, its world view, and its daily management of the parks. To shoulder this responsibility, the Service must conduct scientifically informed management that insists on resource preservation as the highest of many worthy priorities. This priority must spring not merely from the concerns of specific individuals or divisions within the Service, but rather from an enduring institutionalized ethic that is reflected in full-faith support by all environmental laws, in appropriate natural resource policies and practices, in budget and staffing allocations, and in the organizational structures of parks and central offices.

Due to the rapid depletion of natural resources and the diminishing diversity of life in North America during the 20th century, national parks are fast becoming the last remaining havens for once-widespread species and ecosystems. Every conceivable effort must be made to marshal the necessary resources to preserve the integrity of the parks and the life residing within them. In pursuing this goal, the National Park Service should seek to connect parks with adjacent protected lands and waters, creating networks of linked habitats to prevent the isolation of living systems. Further, the Park Service should provide far greater protection for freshwater and marine systems related to units of the National Park System. And it should invite public discussion about protecting other areas of significant ecological concern that are currently underrepresented in the park system.

The Science Committee believes that each national park should serve as a center of enlightenment, and that the National Park Service should serve as the world's leader in stimulating, synthesizing, and utilizing place-based science. With its already-extensive involvement in natural resource preservation, the Service should work through public and private partnerships in a collaborative "virtual institute" for preservation. With these partners, the Park Service should play a catalytic role in creating an "electronic encyclopedia" of natural resource data and analyses gathered from the communities, states, and private sources of this nation, and from other countries worldwide, in a multilateral effort to track the ecological health of the planet.

The report that follows is based on the fundamental premise that public enjoyment and the protection of the natural integrity of the parks are far from being mutually exclusive; rather, they are mutually dependent. Experiencing the wonders inherent in the grand sweep of majestic landscapes, feeling the thrill of encounters with wild creatures, and gaining the knowledge of how we are connected to the natural world all inspire a sense of respect and caring. And, in turn, people who care will insist upon protecting the parks they love.

Natural resources are neither limitless nor infinitely resilient—not trees, not water, not wild animals, not even the nature of the air.

THREATENED AND ENDANGERED SPECIES

Federally listed as endangered, the nene or Hawaiian goose (Nesochen sandvicensis) is resident in Hawaii Volcanoes and Haleakala national parks. To protect the species park staffs control nonnative predators, monitor nesting, and research nutritional requirements of the species.

NATURAL SYSTEMS IN THE 21ST CENTURY

MORE WAS LEARNED ABOUT THE NATURE OF THE WORLD and its wonders in the 20th century than during all preceding history. Some who traveled by horse-and-buggy as children had children of their own who traveled to the moon. Never before had scientific and technological advances been as revolutionary, or as rapid. Three discoveries were especially significant: First was the insight that natural resources are neither limitless nor infinitely resilient—not trees, not water, not wild animals, not even the nature of the air. Second was the realization that humankind is utterly dependent on the world's natural systems for basic goods and services—and, ultimately, for life itself. Living systems of the land and sea generate oxygen, absorb carbon dioxide, yield energy, stabilize temperature, maintain global chemistry, and generally make Earth habitable for the likes of us. Third was the discovery that we can, through our actions, change the way the world functions—that we can alter climate, influence weather, upset natural water regimes, and eliminate thousands of species, and even entire natural systems—and that in so doing, we can jeopardize our own health, wealth, and survival.

In the early 1900s, the nation's treasury of natural resources was full—brimming with clean lakes, free- flowing rivers, and clear coastal waters. Ancient forests, wild deserts, and fertile prairies cloaked the land; and birds and other wildlife abounded even in urbanized areas. Today, much of America's landscape is fragmented and fenced, blanketed with farms and cities, and laced with highways. Dams and levees subdue most rivers, and much wildlife now lives on islands of natural areas separated by great expanses of developed terrain. The surrounding ocean suffers from pollution and the overexploitation of fish and other wildlife.

Although the National Park System was not initially conceived as a safeguard against such troublesome changes to the natural world, this role emerged emphatically beginning late in the 20th century. The ethic that led a youthful, growing nation to establish Yellowstone National Park in 1872—two million acres on which no one could lawfully settle, or extract minerals, timber, or eventually even wildlife—quickly spread to embrace other areas. It is now widely recognized that these natural areas are more than simply esthetically pleasing—that they protect vital watersheds, and harbor fundamental elements of biodiversity—the very fabric of life needed to maintain a healthy world.

In the late 20th century, the idea that ocean resources might benefit from protective measures gave rise to legislation—first in the United States and Australia—to authorize the establishment of marine parks. More than a thousand marine parks now exist worldwide in dozens of countries, although most provide only nominal protection for the wildlife within them. Worldwide, only about 0.001 percent of the ocean is accorded the same level of protection for its wildlife as that considered normal in U.S. national parks. While some species are protected, commercial and sport fishing generally continues within "marine protected areas" at about the same level as outside of these areas. New technologies developed in the past 50 years for finding and catching fish and other ocean life have been so effective that 90 percent of the large fish—swordfish, tuna, marlin, skates, sharks, and others—have been globally eliminated, and entire marine ecosystems have been destroyed through the use of trawling, dredging, and other harmful processes. More than 50 percent of coastal mangroves are gone, and coral reefs have generally declined by 30 percent in the past 30 years.

In the United States, the 60 or so national parks that have some coastal jurisdiction are taking on increasing significance in terms of their potential role in protecting and restoring exploited ocean life and damaged coastal ecosystems. With the declaration by President Ronald Reagan in 1983 of a 200-mile Exclusive Economic Zone extending seaward from the nation's coastline, the area under U.S. jurisdiction increased by about 125 percent, with more territory underwater than above. Now, during the 21st century, there is a particular need for assessing the opportunities and responsibilities of the Park Service concerning this vast aquatic region of the country—to link onshore issues to the ocean, and visa versa; and to build an ocean ethic corresponding to the land ethic that has developed in our national parks and inspired the world with a sense of caring.

National parks . . . are taking on increasing significance in terms of their potential role in protecting and restoring exploited ocean life and damaged coastal ecosystems.

OCEAN RESOURCES

Foggy beach, Olympic National Park, Washington. The National Park Service is becoming an increasingly influential participant in the protection and restoration of marine park resources as it begins to assess the health of its coastal ecosystems and ocean life.

The Challenge represents a concerted effort by the Service to reconcile its budget priorities with its core mission to protect the integrity of the natural resources.

RESOURCE MONITORING

Lake Clark National Park and Preserve, Alaska. Aided by students from a nearby native village, staff of the national park and Southwest Alaska Network use a beach seine to sample resident lake fish. Resource monitoring is funded as part of the Natural Resource Challenge and is designed to track the condition of key park resources over time.

EVALUATING THE NATURAL RESOURCE CHALLENGE

Background

THE NATURAL RESOURCE CHALLENGE began in 1999 as a multi-year program created by Congress at the urgent request of the National Park Service to improve management and protection of natural resources in the National Park System. Prior to the Challenge, Park Service investments in natural resource management were insignificant compared to those in other key functional areas. Presently, the Challenge represents a concerted effort by the Service to reconcile its budget priorities with its core mission to protect the integrity of the natural resources. In addition to increasing the Park Service's natural resource budget from about $100 million per year to $200 million per year, the Challenge includes a range of technical natural resource management strategies to not only provide improved science for parks, but also to establish the concept of "parks for science." This concept relies heavily on partnerships that operate according to the principle that the long-term preservation of national parks will be dependent upon the efforts of many partners—with academe, private enterprise, and the general public—to provide not only a clear science- based understanding of what the long-term protection of parks requires, but also an active dialogue regarding decisions that can be made locally to build a supportive regional context for parks.

In August 2001, with the Natural Resource Challenge underway, the National Park System Advisory Board issued a broadly comprehensive report, Rethinking the National Parks for the 21st Century, which focused on the overall purposes and prospects for the park system for the next 25 years. The thrust and recommendations of this report fully support the goals and core purposes of the Natural Resource Challenge. The Science Committee urges that the Advisory Board report and the present Science Committee report be used to guide the science, natural resource protection, and public enjoyment goals of the National Park System over the next quarter century.

Specific goals of the Natural Resource Challenge are:

1. To increase inventorying and monitoring capability aimed at assessing broad categories of natural resources and the programs needed to protect them unimpaired for future generations.

2. To provide increased support to programs and projects designed to maintain and restore park natural resources, including action to recover endangered species and eliminate exotic species.

3. To improve awareness of parks as "natural laboratories" for use by scientists, especially for taxonomic and ecological research.

4. To ensure that park visitors, residents of communities adjacent to parks, and the general public are connected to the parks through up-to-date and hands-on science education about the results of research activities conducted within the parks.

5. To undertake outreach to partners in universities, federal and state agencies, local science education organizations, and other entities to gain their cooperation in successfully implementing the Natural Resource Challenge.

Evaluation

Our review found that the Natural Resource Challenge, first funded in Fiscal Year 2000 and augmented by funding increments over the next three years, has now achieved more than 65 percent of its goal of doubling Service funding of natural resource preservation activities. To date, funding has been allocated to all components of the Challenge (see appendix), although it has been allocated in unequal amounts according to needs and priorities. The Challenge relies on internal competition to stimulate creativity; peer- reviewed work-plans to encourage efficiency, effectiveness, and the application of best practices; and rigorous reporting, including an annual report to Congress, to ensure measurable accountability and public awareness.

The Natural Resource Challenge is based in the statutory mission of the National Park Service, and is targeted at reducing known shortcomings in past levels of National Park Service support for using science as a management tool. The Challenge's emphasis on inventorying and monitoring directly responds to information gaps identified in both the park-specific 1980 National Park Service "Threats Report," and the broader, nationally focused 2002 Heinz Center Report, "The State of the Nation's Ecosystems—Measuring the Lands, Waters and Living Resources of the United States." The Challenge's support of restoration programs addresses a large, known backlog of natural resource management needs that had not previously been receiving management action.

The Natural Resource Challenge's emphasis on partnerships—whether for the hands-on management of exotic plants, collection of inventory and

The Challenge's support of restoration programs addresses a large, known backlog of natural resource management needs that had not previously been receiving management action.

RESTORING PARK ECOSYSTEMS

Apostle Islands National Lakeshore, Michigan. Resource managers monitor the recovery of the Oak Island sandscape following restoration of 15 native plant species to the site.

monitoring information, or translation of scientific findings through cooperative science education programs at Research Learning Centers, maximizes the impact of each federal dollar. The Challenge relies upon incremental growth in funding, on competition to stimulate creativity and focus, on tracking of funds to ensure accountability, and on reporting of results—all of which work together to form a science-based strategy that is working to improve the condition and interpretation of park natural resources.

Through the Natural Resource Challenge, and in accordance with the National Park Service Strategic Plan, the Service has laudably undertaken to hold itself accountable to the American citizenry for the condition of the parks' natural resources and for greater understanding and enjoyment of these resources. The sea change that has been initiated must be completed by consolidating and extending the benefits of the initial gains of the Challenge, based on a commitment to the Park Service's Strategic Plan and the accountability built into the Challenge. (See appendix for a detailed summary of the Natural Resource Challenge.)

The Committee recommends that the impact and momentum of the Challenge be continued and expanded by engaging the National Park System Advisory Board Science Committee in ongoing peer review of the National Park Service's progress in developing increasingly effective, science-based natural resource management programs. World-renowned scientists deeply interested in the proper care of the National Park System will be eager to promote the concepts embodied in the Natural Resource Challenge and advise on building institutional capacity.

The National Parks Science Committee commends the Park Service, the administration, and the Congress for steadfastly supporting the Natural Resource Challenge.

GLOWWORM (*PHENGODES* SP.), DOCUMENTED AS PART OF THE ALL TAXA BIODIVERSITY INVENTORY AT GREAT SMOKY MOUNTAINS NATIONAL PARK, NORTH CAROLINA AND TENNESSEE. APPROXIMATE LENGTH 0.8 INCH (2 CM).

World-renowned scientists deeply interested in the proper care of the National Park System will be eager to promote the concepts embodied in the Natural Resource Challenge. . . .

ENGAGING CITIZENS IN PARK STEWARDSHIP

Harvard biologist and National Parks Science Committee member Edward O. Wilson and students from Odyssey High School kick off a multiyear project designed to gain a thorough understanding of the biodiversity—particularly invertebrates—of Boston Harbor Islands National Recreation Area in Massachusetts.

Isolated protected areas—including large and small national parks—do not provide adequate habitat essential for the genetic and ecological survival of many species.

HYBRIDIZATION AND NATIVE SPECIES

One of many challenges for natural resource managers this century is the preservation of genetically pure native species. At Voyageurs National Park in Minnesota, for example, a nonnative cattail species has hybridized with a native one, threatening to disrupt many ecosystem services traditionally associated with freshwater wetlands.

FUTURE DIRECTIONS FOR NATIONAL PARK SERVICE SCIENCE

THE AREAS PROTECTED IN THE NATIONAL PARK SYSTEM are critical to the preservation of diminishing local, national, and world biodiversity. The Science Committee emphasizes that the National Park Service must continue to embrace the conservation of biodiversity as a core purpose, as the Advisory Board's 2001 report recommended. And it must continue to strengthen significantly the biodiversity focus of park management, as well as gain the cooperation of other land managers at the landscape level, and further improve science education for the American public.

The Science Committee offers the following recommendations for implementing these overarching goals:

(A) National parks should be part of a national system of protected areas, all of which are connected to form a network of biological linkages throughout North America.

Preventing loss of species from national parks over time depends on functional ecological connectivity among habitats. Isolated protected areas—including large and small national parks—do not provide adequate habitat essential for the genetic and ecological survival of many species. The Science Committee commends the National Park Service for its advocacy of a "seamless system of parks, historic places and open spaces"—a nationwide network of park lands and protected areas. In promoting this idea, the National Park Service lends its influence to an emerging collaboration of visionary partners—organizations seeking to create biological linkages across our country.

The National Park Service, working with state, local, and private entities, should:

1. Evaluate the broad range of North American terrestrial, freshwater, and marine ecosystems, and the extent to which the National Park System represents each component of these ecosystems.

2. Examine how parks are parts of ecosystems, and how biological linkages will help achieve sustainable ecosystems and communities, including assess-

Visitors who interact with nature in a park setting are unlikely to forget the experience.

PLACE-BASED EDUCATION

Olympic National Park, Washington. Park visitors expand their knowledge of tide pool ecology with the help of an interpretive park ranger. Educational opportunities strengthen the bonds between people and their national parks and raise awareness about biodiversity conservation.

ments of stresses on park resources from rapidly changing global, regional, and local landscapes.

3. Identify how greenways, trails, riverways, and other publicly designated recreation corridors can be utilized and/or enhanced to contribute to maintaining biological linkages.

4. Demonstrate the best management practices and cooperative adaptive management models, and publicize case studies and successes.

5. Emphasize, throughout, how biological connectivity links people intellectually, emotionally, and physically to their landscapes.

(B) The National Park Service should expand its involvement in the protection of freshwater and marine systems related to units of the National Park System.

Aquatic and marine plants and animals must be recognized as wildlife that has status equal to that of terrestrial wildlife. The National Park Service is responsible for ensuring that biodiversity is protected within park waters. In accordance with that responsibility, the Service should be a proactive player in a national dialogue to develop a strategy for marine resource protection and restoration that is based on the interconnection between terrestrial, freshwater, and marine systems, and that involves partnerships with other freshwater- and marine-system professionals.

In this regard, the National Park Service should:

1. Encourage the interagency development of national standards for how marine resources can be managed sustainably, including through the expansion of the system of marine protected area designations and the implementation of ecologically sound practices regarding fish and other wildlife.

2. Recognize the interconnectedness of freshwater and marine resources, and give high priority to protecting the biodiversity of streams, ponds, rivers, lakes, and wetlands within units of the National Park System, and within the watersheds both upstream and downstream from those units.

3. Ensure that all national standards for sustainable marine resource management are met in parks.

(C) The National Park Service should serve as both educator and advocate, using scientific and traditional knowledge as the foundation for managing natural and cultural resources.

National parks are exceptional places in which to learn how to make our natural ecosystems more sustainable in their interactions with surrounding human communities. In particular, it is critical that we integrate empirical science with local ecological knowledge to safeguard natural and cultural landscapes in the national parks and national monuments. Visitors who interact with nature in a park setting are unlikely to forget the experience. As stewards of the parks, the National Park Service has a unique opportunity to improve the scientific literacy of the citizens of this nation and help foster a national stewardship ethic.

To respond to this opportunity, the National Park Service should:

1. Integrate the perspectives of cultural and natural scientists, in collaboration with traditional elders and leaders from surrounding ethnic communities, in the restoration or protection of natural and cultural landscapes.

2. Inform visitors and other park partners about the status and trends of park biodiversity, and encourage them to learn about, and take pride in, park biodiversity and the actions needed to preserve it for future generations.

3. Develop core messages and methodology for place-based education that connects the public to their roles in protecting local, regional, and global biodiversity, as well as their linkages in terrestrial, freshwater, and marine ecosystems.

4. Work with science teachers at all educational levels, both on site and off site. Bring science teachers into the parks to work as seasonal employees and thereby acquire new knowledge to present in their classrooms.

5. Ensure that National Park Service messages address and are available to all levels of educational interest, including the continuing education of diverse audiences and new citizens.

6. Improve the scientific knowledge of interpreters, including both National Park Service and non-Service personnel working in, or with, national parks.

7. Deliver educational information to the public by means of regular media exposure, including, for instance, the web, television, print, broadcast, journalism, interactive multimedia, and video games.

It is critical that we integrate empirical science with local ecological knowledge to safeguard natural and cultural landscapes in the national parks and national monuments.

HOLISTIC MANAGEMENT

Oak woodlands and prairies of Redwood National and State Parks, California, are managed as natural components of a cultural landscape. Prescribed burning approximates natural sources of ignition and cultural use of fire, maintaining these park areas. Large tanoaks, tended and used as sources of acorns by ancestors of present-day Yurok, are protected from fire.

8. Create links with individuals and institutions involved in science education, such as aquariums, zoos, and botanical gardens, and other science groups and foundations, in order to work with them to improve science education, taking advantage of contemporary educational techniques.

9. Determine ways to measure educational success, and use these findings to initiate and expand successful strategies.

(D) Ensure institutional capacity.

To achieve its mission, the National Park Service must enhance its existing infrastructure. Through the Natural Resource Challenge, the Service is increasing its highly trained personnel, and the funding for needed programs; creating necessary laboratory space and residential space; and enhancing its capabilities for carrying on essential inventorying, monitoring, field research, adaptive management, and science education. More needs to be done.

It is also critical that the National Park Service manage its own science program, including research funding and priority setting.

An adequate National Park Service science program must have three components: First, the Natural Resource Challenge provides the tools for basic data collection, retrieval, and storage. Second, the U.S. Geological Survey (USGS) and academic researchers provide individual scientific studies of national park resources and issues, through the stimulus of the Natural Resource Challenge program "parks for science" emphasis. The third component making up a systems ecology program—one that provides the tools for long-term institutional memory—is currently missing. In regard to this missing component, in order to identify and effectively address scientific knowledge gaps in the parks, it is extremely important that the National Park Service establish and manage its own cadre of science synthesizers. This program needs to be supported by research funds that ensure scientific responsiveness to park management priorities, competition, flexibility, and cost containment. The Park Service science capability should include what no partner can provide: an institutional memory that arises from career National Park Service scientists working in parks over many years. To achieve this capability, the Service must recruit systems ecologists and other science synthesizers. Over the long term, these personnel will develop a deep, cumulative, and usable corporate memory that will provide the breadth and depth of knowledge necessary to inform park management about preserving the integrity of the national parks in perpetuity.

The Park Service science capability should include what no partner can provide: an institutional memory that arises from career National Park Service scientists working in parks over many years.

Career scientist Gary Davis (retired). Marine biologist, Channel Islands National Park 1980–2007; National Park Service employee 1964–2007.

INSTITUTIONAL MEMORY

The National Park Service needs to expand its staff of career scientists who have a deep and broad understanding of systems ecology. These science synthesizers are necessary to develop and pass on usable scientific knowledge, gathered through decades of park-based work, for the effective management of the national parks.

In regard to these components, the National Park Service should:

1. Establish a resident agency capacity to manage, conduct, and synthesize research, as well as to maximize connections with professional and partner organizations.

2. Provide national park managers with enough training in science to understand and fully commit to the role of science in resource management and park operations.

3. Ensure that National Park Service training includes opportunities for advanced, continuing education in scientific natural resource management and related fields, as a means of maintaining professionally up-to-date staff. Similarly, increase support for offering in-park sabbaticals to researchers from academic and professional organizations.

4. Restructure career paths to allow resource professionals to stay in one location, gain on-site expertise, and develop local working relationships without losing opportunities for professional advancement.

5. Develop a data and information management system, so that each park has a system for making decisions; and also develop a collections management system to ensure preservation for, and access to, natural resource data specimens.

6. Engage Cooperative Ecosystem Studies Unit (CESU) scientists in developing and providing continuing education seminars focused on conservation science for NPS leadership; in regularly briefing park superintendents and resource managers on emerging natural and cultural resource issues; and in identifying the best science available to resolve these issues.

(E) Tell America's story as one of diverse cultures interacting with and depending upon the natural world.

All parks should be interpreted in terms of both their natural and cultural values, including their values to all Americans. Park management should reflect a dynamic understanding of the significance of each landscape as a culturally formed mosaic of habitat, historically shaped by changing natural processes and human action.

The National Park Service should:

1. Determine the prehistoric and historic interactions between resident human cultures and the plants, animals, water, and land upon which they depended, and ensure that the significance of these phenomena is closely considered before management actions are taken in any unit of the National Park System.

2. Understand how the cultural history of human interactions with the natural resources upon which they depended has changed through time, especially with respect to impacts on biodiversity.

3. Where warranted and possible, apply scientific and scholarly study to learning how to restore landscapes associated with architectural features to reflect the natural, cultivated, or agricultural historic scene that gives those features their contextual significance.

4. Investigate whether the traditional harvesting of foods, medicines, and ceremonial biological items was sustainable over many human generations, and assess the potential today for parks to provide opportunities for small-scale uses of traditional activities to help local ethnic groups maintain their ethnic values and to interpret how such uses can be sustainable.

(F) Encourage the creation of an integrated national database on America's natural heritage.

Park inventorying, monitoring, and applied research activities regularly generate scientific information about parks. This information not only directly benefits park managers and park visitors, but it also contributes significantly to a better public understanding of the state of the nation's environmental health. Currently, information about all of the natural heritage of our country is being assembled separately by a wide array of public and private agencies—but it is highly fragmented. There is a need to integrate this information through systems that ensure the data is accessible and inter-operable.

The National Park Service should:

1. Work with a "virtual consortium" of academe, professional societies, the private sector, and other federal, state, and local agencies, to develop and maintain an "Electronic Encyclopedia of America's Natural History."

2. Continue large-scale all-species inventories like those currently underway at Great Smoky Mountains National Park.

3. Develop park inventorying and monitoring programs in ways that add information to the evolving database, reflect the status of parks, and increase awareness in park visitors and the American public of the connections between parks and all natural resources and systems in the nation.

4. Strengthen support for the National Natural Landmarks Program, which facilitates voluntary private landowner participation in the preservation of scientifically valuable and unique sites in the United States. The National Park Service should request that the National Park System Advisory Board immediately resume its role in reviewing new nominations and recommending deletions and boundary changes when proposed.

SPREAD-WINGED DAMSELFLY (ABOVE, FAMILY LESTIDAE) AND ADULT MALE DOBSONFLY (RIGHT, *CORYDALUS CORNUTUS,* APPROXIMATE LENGTH 3 INCHES [7.5 CM]), DOCUMENTED AS PART OF THE ALL TAXA BIODIVERSITY INVENTORY AT GREAT SMOKY MOUNTAINS NATIONAL PARK, NORTH CAROLINA AND TENNESSEE.

SUMMARY

OVER THE NEARLY 90 YEARS SINCE ITS FOUNDING IN 1916, the National Park Service has been widely recognized for its success in providing an unparalleled level of visitor services and experiences to citizens of the United States and visitors from around the world. In contrast, Park Service development of the science capability necessary to fulfill its natural resource preservation mandate has been slow and erratic, at best. However, the Natural Resource Challenge, urgently promoted by the Service to a supportive Congress and Executive Office, represents a historic change in the Service's thinking about its natural resource responsibilities. The Challenge has brought remarkable progress in developing the necessary scientific capacity to inform national park decision making. The National Park Service must maintain—and build upon—this momentum.

In recent years, many people have expressed the opinion that national parks are "being loved to death"— that is, that public visitation has become so great as to damage park resources. The Science Committee does not believe this. While impacts upon resources from visitors do occur, they can be mitigated through better planning—and especially through the application of scientific information to planning and overall park management. The Committee believes it is essential to the preservation of the national park idea for the public to discover and visit the national parks, and it recognizes that public enjoyment and ecological preservation of the parks are not mutually exclusive. At the same time, it believes that it is critical that the National Park Service raise to a new level its commitment to the fundamental purpose of preserving the parks unimpaired for all time.

The Science Committee believes that, given the high public regard for the national parks and the National Park Service, there is great potential for the organization to play a significant leadership role in the 21st century, thereby advancing the preservation of natural heritage in the United States—and perhaps throughout the world. But to assert the influence that it can, and to become the world leader that it must be, the Park Service must continue to develop a robust, professional scientific natural resource management program. The Committee finds that it is absolutely essential for scientific knowledge to form the foundation for any meaningful effort to preserve ecological resources in the National Park System. In pursuing this course, the Park Service will add immeasurably to America's collective scientific knowledge; ensure that the parks serve ever more significantly as national observatories for the long- term study of ecology and biodiversity; and further enhance the value and benefits of parks for the American people.

The Challenge has brought remarkable progress in developing the necessary scientific capacity to inform national park decision making. The National Park Service must maintain—and build upon—this momentum.

Appalachian National Scenic Trail, New Hampshire

APPENDIX
Contribution of Natural Resource Challenge Components to "Science for Parks" and "Parks for Science"

Science for Parks

Increase Park Base Funds

Increases park budgets to expand their capabilities for applying scientific solutions to managing park natural resources.

Create Biological Resource Management Division

Restores an NPS capability for providing parks with technical management support in biology that augments park staff skills, by providing services of scientific specialties not found in parks. Specialties provided by this new, 12-person division include threatened and endangered species recovery; exotic species removal; integrated pest management; large wild animal live capture and tracking; veterinary services for wild animals; ecosystem restoration, including restoration of natural fire regimes; and migratory bird conservation.

Increase Project Funding Available to Parks for Solving Specific Natural Resource Problems

Improves opportunities for parks to secure one-time, project-specific funding to fill high-budget, non- recurring natural resource preservation needs.

Create Exotic-Plant Management Teams

Funds 16 teams of NPS and/or partner technical specialists to manage exotic plant infestations in parks, under the direction of the Biological Resource Management Division, and in consultation with superintendent committees. Each team is assigned a group of parks to support, and each team maintains the capability for finding exotic plants, and removing them, and restoring native vegetation to treated areas.

Increase Funding for Inventorying and Monitoring

Funds networks of parks in conducting GIS-based inventories of 12 categories of natural resources and long-term monitoring of

selected indicator natural resources. Develops park conceptual ecosystem models and inventorying and monitoring protocols to guide park activities. Assigns three or more scientists to each network to provide inventorying, monitoring, and data management specialists to guide the network program. Seventeen networks supporting 153 parks have been funded out of a total of 32 networks supporting approximately 270 parks.

Establish NPS Partnership in Cooperative Ecosystem Studies Units (CESUs)

The NPS actively participates in interagency efforts to develop a 17-unit network of cooperative partnerships among federal and state agencies, universities, tribal governments, and non-governmental organizations, to jointly support and conduct scientific and scholarly research, technical assistance, and educational activities in physical, biological, social, and cultural resource sciences. Funds support one NPS position duty-stationed at the host university in each of 12 CESUs out of a planned total of 17 NPS positions for the 17 CESUs.

Continue Canon USA, Inc., Support to Parks

Continue the partnership with Canon USA, Inc., to fund the Canon National Parks Science Scholars for the Americas Program in support of doctoral research throughout the Western Hemisphere. Today's Canon National Parks Science Scholars for the Americas Program is a collaboration among Canon U.S.A., Inc; the American Association for the Advancement of Science; and the National Park Service, which is structured to award eight dissertation research scholarships to Ph.D. students throughout the Americas for conducting research critical to conserving the national parks of the region. Research projects may be in the biological, physical, social, and cultural sciences, as well as in technology innovation in support of conservation science.

Parks for Science

Create Research Learning Centers

Creates the capability for attracting researchers to work in park networks by providing for lodging, laboratory space, logistics support, and other needs. Creates the capability for helping visitors and residents of adjacent communities to learn what the researchers are finding out about park resources, by providing lecture

rooms, teaching laboratory space, and direct access to researchers and research reports. NPS funds two positions for each learning center, one to provide science liaison, and the other to provide science education outreach. Partners provide funds and personnel to work alongside NPS personnel. NPS and/or partners provide, where necessary remodel, and equip existing facilities to serve the lodging, laboratory, and teaching needs of the centers. Thirteen learning centers have been funded and established, and another 19 have been identified as candidates for establishment.

Provide Research Permit and Reporting System

Invites researchers to work in parks by providing them with an Internet-based, automated mechanism to apply to parks for Scientific Research and Collecting Permits and to submit their required Investigator's Annual Reports; shares the resulting scientific information by providing other researchers and the public with access to multi-year database of Investigator's Annual Reports submitted in past years.

Establish Sabbatical-in-the-Parks Program

Creates an Internet-based capability for attracting university professors who are conducting sabbatical scholarly activities to work in, and match them with, parks that are interested in providing support as a means of enabling the specialists to work on topics of benefit to the parks. Develops a process enabling university professors and parks to enter into agreements related to how each will benefit the other as part of the sabbatical in the parks partnership. More than 10 professors have submitted formal proposals for a partnership.

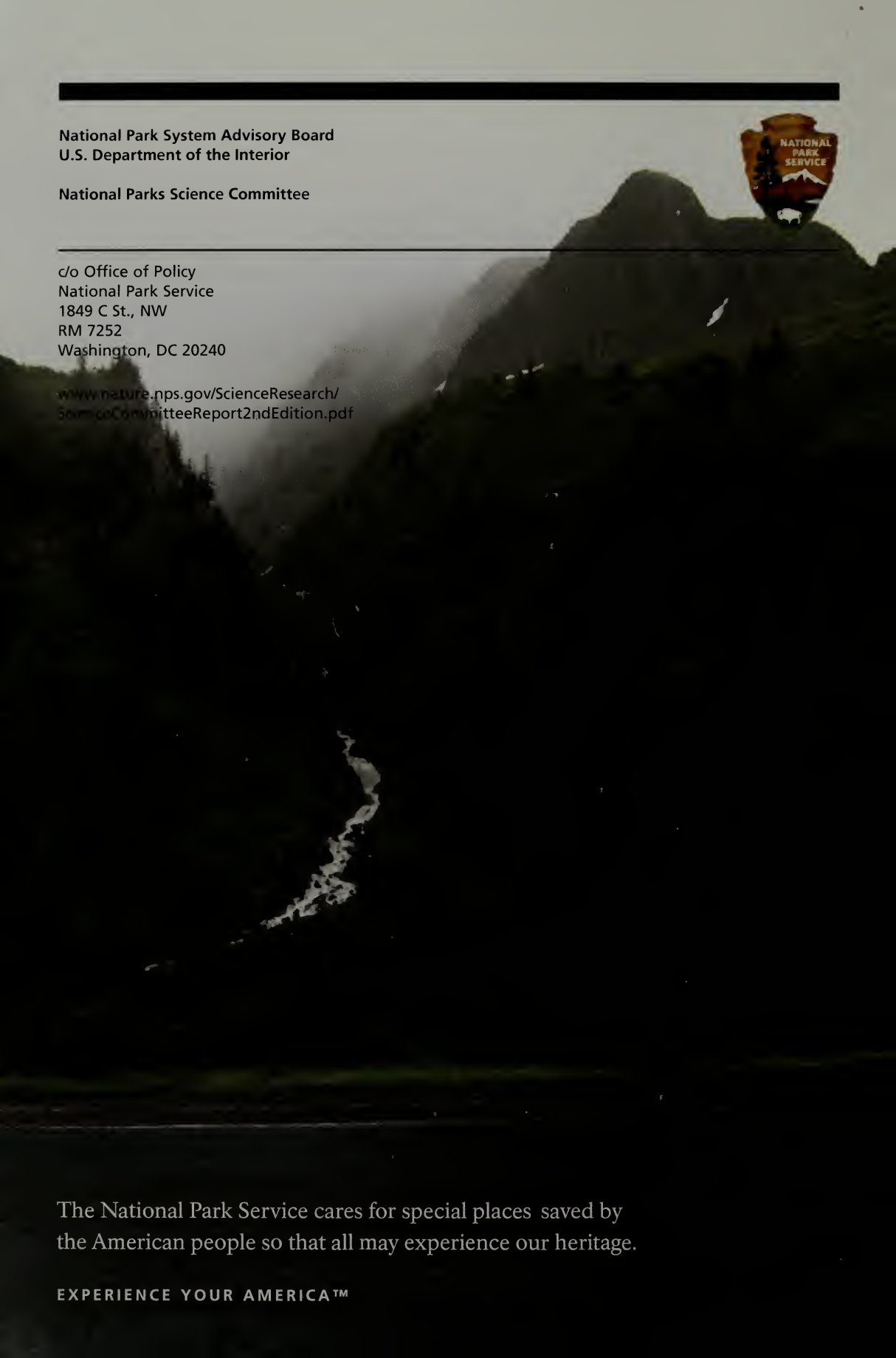
Facilitate Mellon Fellowships

A Mellon Foundation grant funds a partnership involving the Ecological Research Fellowship Program. This program provides 1- to 3-year post-doctoral fellowships to support research in any area of ecology related to the plant dynamics of national parks. The program awarded five fellowships in its first 2 years of existence.

Century plant (*Agave havardiana)*, Big Bend National Park, Texas.

Suggested Citation
National Parks Science Committee. 2009. National Park Service science in the 21st century. Second edition. Report D-1589A. National Park Service, Lakewood, Colorado, USA.

Illustrations/Credits
Cover NPS/Jennifer Gibson; **ii** (verso half title page) NPS; **iv** (verso title page) Copyright Martin Hutten; **vi** Copyright Jeff Selleck; **viii** NPS/Jeff Selleck; **2** NPS; **4** Copyright Jeff Selleck; **7** NPS/Gary Davis; **8** NPS/Alan J. Bennett; **11** NPS/Julie Van Stappen; **12** NPS/Great Smoky Mountains National Park (2); **13** NPS/Boston Harbor Islands National Recreation Area; **14** NPS/Joy Marburger; **16** NPS/Gary Davis; **19** NPS; **21** Courtesy of Dorothy Davis; **24** NPS/Great Smoky Mountains National Park (2) **26** Tim Cummings, courtesy of the Appalachian Trail Conservancy **30** Copyright Jeff Selleck; **Back Cover** (Kenai Fjords National Park, Alaska) NPS/Gary Davis; **Second edition layout and captions** Jeff Selleck, Natural Resource Program Center, Office of Education and Outreach.



National Park System Advisory Board
U.S. Department of the Interior

National Parks Science Committee

c/o Office of Policy
National Park Service
1849 C St., NW
RM 7252
Washington, DC 20240

www.nature.nps.gov/ScienceResearch/
ScienceCommitteeReport2ndEdition.pdf

The National Park Service cares for special places saved by the American people so that all may experience our heritage.

EXPERIENCE YOUR AMERICA™